Nov. 18, 1952 L. RING 2,618,292

VALVE FOR DIE CASTING MACHINES

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FIG. 1

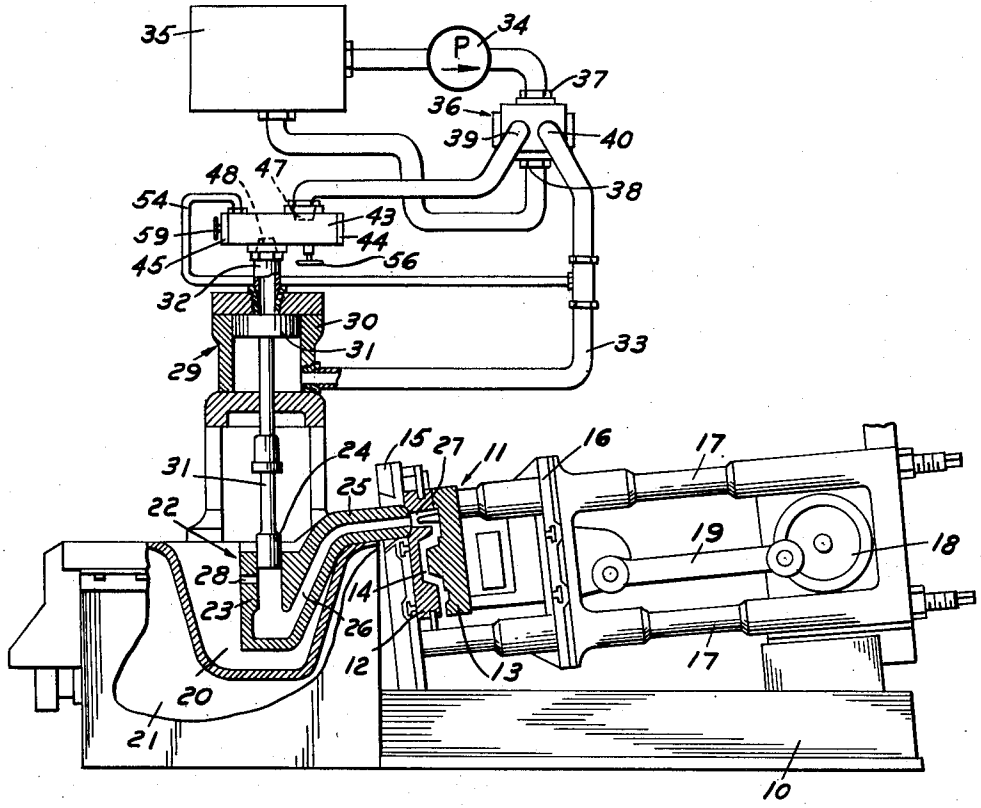
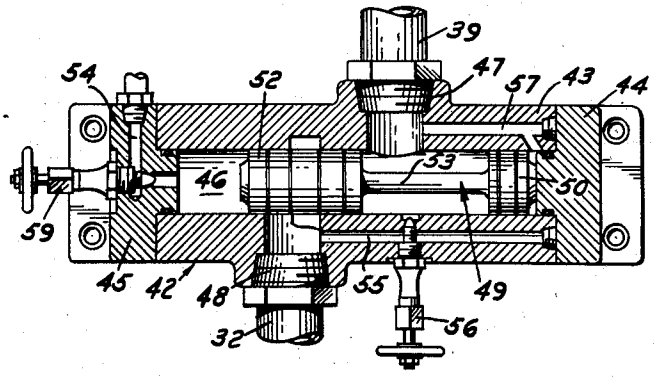


FIG. 2



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VALVE FOR DIE CASTING MACHINES

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3 Claims. (Cl. 137—675)

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This invention relates to die casting machines of the type wherein the material to be cast is forcibly injected into the die cavity.

It is an object of this invention to provide a valve which renders a die casting machine automatic in operation, and which causes the machine to produce uniform substantially nonporous castings having unusually smooth surface finishes with no special attention or manipulation required on the part of the operator. Thus relatively unskilled operators may be employed without affecting the quality of the castings, and uniformity of the castings is assured.

In accordance with this invention, substantially nonporous castings having superior surface finishes are obtained by forcibly injecting the material into the die cavity in two stages. In the first stage the material is gradually fed into the die cavity at a rate such that any air or gas present in the cavity has a chance to escape through the vent provided in the cavity for this purpose before the material solidifies. In the second or final stage, the rate of feed of the material is greatly accelerated; so that the material, in effect, is shot into the cavity and fills all portions of the cavity before solidification takes place.

It is another object of this invention to provide a valve for a die casting machine of the above type wherein the two stages of injection are automatically effected in the operating cycle of the machine, and wherein the feeding rates as well as the timing between the two stages may be readily varied to suit different conditions.

The foregoing as well as other objects will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawing, wherein:

Figure 1 is a semidiagrammatic view partly in section of a die casting machine embodying the features of this invention; and

Figure 2 is a longitudinal sectional view through a part of the machine shown in Figure 1.

It will be understood as this description proceeds that the present invention may be successfully used in connection with numerous different types of die casting machines. However, for the purpose of illustration, I have shown in Figure 1 a die casting machine having a base 10 and a die 11. The die 11 has two parts 12 and 13 which cooperate with one another to form a cavity 14.

The die part 12 is fixed on a plate 15 which extends generally vertically from the base 10, and the cooperating part 13 is suitably supported on a plate 16. The plate 16 is mounted on guides 17 which in turn, are supported on the base 10 in a manner to provide for sliding movement of the die part 13 toward and away from the die part 12. In the present instance a suitable power driven crank 18 is also supported on the base 10 and is connected to the plate 16 by a rod 19

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for moving the die part 13 into and out of engagement with the cooperating die part 12.

The material or metal to be cast into the die cavity 14 is normally stored in a melting pot 20, which projects into a furnace or heating chamber 21. The furnace 21 is also supported on the base 10, and incorporates heating elements of any suitable type for maintaining the material in the pot 20 in a molten state.

It will further be noted from Figure 1 of the drawing that a die charging pump 22 is suitably mounted within the pot 20. This pump comprises a vertically extending cylinder 23 and a plunger 24 supported in the cylinder for sliding movement relative thereof. The cylinder 23 is closed at the bottom, and is fashioned with a goose-neck nozzle portion 25. The nozzle portion 25 extends upwardly through the top of the pot 20, and projects through the die supporting plate 15 into engagement with the stationary die part 12 at a point spaced laterally above the cavity 14. A discharge passage 26 is formed in the goose-neck portion 25 and connects the lower end of the cylinder 23 to the cavity through the medium of a sprue opening 27 in the die. It will be understood that the exposed portions of the goose-neck 25 may be heated by any suitable means (not shown) to insure that the molten metal or material is maintained at the proper temperature as it passes therethrough.

The cylinder 23 is also shown in Figure 1 of the drawing as having an inlet port 28 located to enable the flow of molten metal from the pot 20 into the cylinder 23 below the plunger 24 when the latter is in its raised position. The arrangement is such that downward movement of the plunger 24 from its raised position in the cylinder 23 forces molten metal through the passage 26 and sprue opening 27 into the die cavity 14. On the other hand, return movement of the plunger 24 to its raised position uncovers the inlet port 28 and permits another charge of molten metal to flow into the cylinder 23 below the plunger.

The plunger 24 is reciprocated in the cylinder 23 by a hydraulic cylinder assembly or motor 29 suitably supported above the melting pot 20. The assembly 29 comprises a vertically extending cylinder 30 and a piston 31 slidably supported in the cylinder. The plunger 24 is connected to the piston by a vertical rod 31 which extends upwardly through the bottom of the cylinder 30.

The upper end of the cylinder communicates with a conduit 32, and the lower end of the cylinder communicates with a conduit 33. In operation these conduits are alternately connected to a source of hydraulic fluid under pressure 34 and a reservoir 35 through the medium of a four-way valve 36. In accordance with conventional practice the valve 36 has a port 37 which is connected to the source of fluid under

pressure 34 and has a port 38 which is connected to the reservoir 35. Also the valve 36 has a pair of ports 39 and 40 which are respectively connected to the conduits 32 and 33. The valve 36 may be any one of a number of designs available to the trade, and is therefore not shown in detail herein. It will suffice to point out that during operation of the casting machine the valve 36 is operated automatically to alternately connect opposite ends of the cylinder 30 to the source of fluid under pressure 34 and to the reservoir 35.

Also in accordance with the present invention, downward movement of the plunger 24 to inject molten metal into the die cavity 14 is automatically controlled, so that initial downward movement of the plunger 24 is effected at a relatively slow rate, and final movement of the plunger in a downward direction is effected at a rapid rate. In practice the rate of initial movement of the plunger 24 is determined to provide ample time for air or gas entrapped in the die cavity 14 to escape through the vent 41 in the die, and the final stroke of the plunger 24 is accomplished at such a rapid rate that the metal is actually shot into the die cavity. Thus complete filling of all portions of the die cavity is assured after all gases or air are evacuated from the die cavity, and accordingly, a dense relatively nonporous casing results.

The downward stroke of the plunger 24, or in other words, the flow of molten metal into the die cavity 14 is controlled by interposing between the four-way valve 36 and the top of the cylinder 30, a valve 42 of the type shown in Figure 2 of the drawing. The valve 42 has a cylinder 43 closed at both ends by caps 44 and 45 which cooperate with the cylinder to form a chamber 46. The cylinder 43 has a pressure inlet port 47 intermediate the ends of the chamber 46 and communicating with the port 39 of the four-way valve, in order to receive fluid under pressure from the source 34 before this fluid is admitted to the upper end of the cylinder 30. The cylinder 43 is also formed with a pressure outlet port 48 communicating with the chamber 46 at a point between the port 47 and the cap 45. The port 48 is also connected to the upper end of the cylinder 30 through the medium of the conduit 32.

The flow of fluid under pressure from the inlet port 47 to the outlet port 48, or in other words, to the upper end of the cylinder 30 is controlled by a valve member or spool 49 of the balanced pressure type and supported for sliding movement in the chamber 46. The valve spool has a head 50 at one end and a head 52 at the opposite end connected to the head 50 by a reduced part 53. The head 50 slides in the chamber 46 between the cap 44 and pressure inlet opening 47. The valve head 52 on the other hand slides in the chamber 46 between the cap 45 and pressure inlet port 47, and controls the outlet port 48. In this connection it will be noted that when the valve spool 49 is in the position thereof shown in Figure 2 wherein the head 50 abuts the cap 44, the outlet port 48 is closed by the head 52. Movement of the valve spool forwardly from the above position or in a direction toward the cap 45 positions the valve head 52 between the cap 45 and outlet port 48 in a position to connect the outlet port 48 to the inlet port 47.

The valve member 49 is normally held in the position thereof shown in Figure 2 of the drawing by the presence of hydraulic or noncompressible fluid medium within the space in the chamber 46 between the valve head 52 and cap 45. In this connection, it will be noted that the cap 45 has a passage 54 therein connected at one end to the port 40 in the four-way valve 36 or to the conduit 33 leading from the bottom of the cylinder 30 and connected at the other end to the chamber 46. Thus when the lower end of the cylinder 30 is connected through the four-way valve 36 to the source of fluid under pressure 34, the space between the cap 45 and adjacent head 52 on the valve spool 49 is filled with the fluid medium, and since the latter is noncompressible, it follows that the valve spool 49 is maintained in the position thereof shown in Figure 2.

It will further be noted from Figure 2 of the drawing that the valve cylinder 43 is formed with a passage 55 which connects the pressure outlet port 48 to the chamber 46 opposite the inlet port 47, or in other words, at a point between the valve heads 50 and 52. Thus the passage 55 bypasses the head 52 on the valve spool 49, and enables the flow of fluid under pressure from the port 47 to the outlet port 48 when the valve spool 49 is in the position shown in Figure 2 of the drawing. The rate at which the fluid under pressure is bypassed is regulated by a needle valve 56 positioned to vary the effective cross sectional area of the passage 55 from zero to a predetermined maximum. In other words the needle valve 56 renders it possible to vary the rate of initial downward movement of the plunger 24 to charge the die cavity 14 with molten metal.

Referring again to Figure 2 of the drawing, it will be noted that the pressure inlet port 47 is connected by a passage 57 to the space in the chamber 46 between the valve head 50 and the cap 44. The purpose of the passage 57 is to enable movement of the valve spool 49 in a direction to displace fluid from the chamber 46 in advance of the head 52 through the passage 54. It will be understood that the rate of displacement in advance of the valve head 52 controls the time of opening of the pressure outlet port 48, and this timing may be varied by metering valve 59 positioned to regulate the rate of fluid flow through the passage 54.

Operation

It will be understood from the foregoing that when the four-way valve 36 is operated to connect the lower end of the cylinder 30 to the source 34 of fluid under pressure and to connect the upper end of the cylinder 30 to the reservoir, the plunger 24 is in its uppermost position wherein molten material from the pot 20 is free to flow through the inlet port 28 into the cylinder 23 below the plunger 24. Also when the four-way valve 36 is in the above position, the valve spool 49 assumes the position thereof shown in Figure 2 of the drawings, and the space in the valve chamber 46 in advance of the valve head 52 is filled with hydraulic or noncompressible fluid medium.

Assuming now that it is desired to charge the mold cavity 14, the four-way valve 36 is moved to connect the lower end of the cylinder 30 and passage 54 in the valve 42 to the reservoir 35, and to connect the pressure inlet port 47 of the valve 42 to the source 34 of fluid under pressure. As a result fluid under pressure flows through the port 47 into the space in the valve chamber 46 between the valve heads 50 and 52, which space also communicates with the by-pass passage 55. As a result fluid under pressure is bypassed to the outlet port 48 or upper end of the cylinder 30 at a rate determined by the metering valve 56. Con-

sequently, pressure is gradually built up in the cylinder 30 above the piston 31; and the latter, together with the plunger 24, is moved downwardly at a relatively slow rate.

As the plunger 24 moves downwardly the port 28 is closed and molten metal in the cylinder 23 below the plunger is forced through the passage 26 into the die cavity 14. The relatively slow rate of feed of the molten material into the die cavity 14 affords ample time for any air or gas in the cavity 14 to escape through the vent 41 in the die.

Also during the above operation fluid under pressure flows from the pressure inlet port 47 through the passage 57 into the valve chamber 46 between the cap 44 and the valve head 50. The force resulting from the pressure acting on the head 50, moves the valve spool 49 in a direction toward the cap 45. Since the space in the valve chamber 46 in advance of the valve head 52 is connected to the reservoir 35 through the passage 54, it follows that the valve spool moves forwardly at a rate depending upon the setting of the metering valve 59 or upon the rate of escape of fluid through the passage 54 to the resorvoir 35. Eventually sufficient fluid in advance of the head 52 is displaced to connect the pressure outlet port 48 directly to the pressure inlet port 47. When this takes place fluid under pressure flows in a relatively unrestricted manner to the upper end of the plunger operating cylinder 30 and downward movement of the plunger is greatly accelerated. Accordingly the rate of flow of molten metal into the die cavity 13 is correspondingly accelerated, and the cavity is suddenly completely filled with the molten metal. The accelerated movement of the plunger 24 is, of course, delayed until all air or gas has been expelled from the die cavity 14, and the interval in the cycle at which acceleration of the plunger is effected may be varied by the metering valve 59.

After the die cavity 14 is completely charged the four-way valve 36 is manipulated to again connect the upper end of the cylinder 30 or the pressure inlet port 47 to the reservoir 35, and to connect the lower end of the cylinder 30 as well as the passage 54 to the source 34 of fluid under pressure. Thus the plunger 24 is not only returned to its uppermost position in the cylinder 23, but the valve spool 49 is also returned to the position shown in Figure 2 of the drawing, wherein the pressure outlet port 48 is closed by the valve head 52, and the space between the head 52 and cap 54 is filled with hydraulic fluid medium.

What I claim as my invention is:

1. Means for controlling the flow of fluid between a source of fluid under pressure and a fluid motor, comprising a valve having a cylinder and a piston supported in the cylinder for sliding movement between positions adjacent opposite ends of the cylinder, said cylinder having a first port opening into the space between one end of the cylinder and the adjacent end of the piston, said first port being adapted to supply fluid under pressure to said space to move the piston toward the other end of the cylinder and being adapted to conduct fluid away from said space upon movement of the piston toward said one end of the cylinder, said cylinder having a second port opening into the space between the said other end of the cylinder and the adjacent end of the piston, said second port being adapted to supply fluid under pressure to the second mentioned space to move the piston toward said one end of the cylinder and being adapted to conduct fluid away from the second mentioned space upon movement of the piston toward said other end of the cylinder, said second port having valve means therein for reducing the effective size thereof and restricting the flow of fluid therethrough to retard the movement of the piston toward said other end of the cylinder, said cylinder having an outlet port positioned to be closed by the piston in its position adjacent said one end of the cylinder and to be opened by the piston upon movement of the latter toward said other end of the cylinder, said cylinder having an outlet passage in communication with the first port when the outlet port is closed by said piston, and said outlet passage being relatively restricted as compared to the outlet port to restrict the flow of fluid therethrough to a rate less than that permitted through said outlet port.

2. Means for controlling the flow of fluid between a source of fluid under pressure and a fluid motor, comprising a valve having a cylinder and an inlet port opening into said cylinder, a piston supported in the cylinder for sliding movement between positions adjacent opposite ends of the cylinder and having spaced heads positioned at opposite sides of the inlet port, said cylinder having a second port opening into the space between one end of the cylinder and the adjacent piston head, said second port being adapted to supply fluid under pressure to said space to move the piston toward the other end of the cylinder and being adapted to conduct fluid away from said space upon movement of the piston toward said one end of the cylinder, said cylinder having a third port opening into the space between the said other end of the cylinder and the adjacent piston head, said third port being adapted to supply fluid under pressure to the second mentioned space to move the piston toward said one end of the cylinder and being adapted to conduct fluid away from the second mentioned space upon movement of the piston toward said other end of the cylinder, said third port having valve means therein for reducing the effective size thereof and restricting the flow of fluid therethrough to retard the movement of the piston toward said other end of the cylinder, said cylinder having an outlet port positioned to be closed by one of the piston heads in the position of said piston adjacent said one end of the cylinder and to be opened upon movement of the piston toward said other end of the cylinder, said cylinder having an outlet passage opening into the space between the piston heads, and said outlet passage being relatively restricted as compared to the outlet port to restrict the flow of fluid therethrough to a rate less than that permitted through said outlet port.

3. The construction defined in claim 2 wherein the valve means in said third port is adjustable to vary the effective size of the latter and consequently the flow of fluid therethrough, thereby to vary the rate of travel of the piston and hence the time required to open the outlet port.

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